Remarks

Preliminary Matters

Claims 1-39 are presented for reconsideration. Claims 1, 2, 5, 9, 10-14, 17, 22-28, and 31-37 have been amended. Claims 38-39 have been added.

Applicant thanks Examiners Silver and Shah for the courtesy of the interview held at the USPTO on 27 November 2007 with Applicant's representative, Sanford T. Colb (Reg. No. 26,856). At the interview, Mr. Colb presented a draft amendment to the claims. The Examiners agreed that this amendment would distinguish the claimed invention over the cited art (Govil), and would apparently overcome the other claim rejections, as well. Applicant has amended the claims accordingly. The Examiners drew Applicant's attention to a set of slides available at http://www.cs.jhu.edu/~yairamir/cs437/week7/sld003.htm. Applicant has considered these slides in preparing the remarks below.

Amendments to the Drawings.

The attached new sheets include corrected Fig. 1 and Fig. 4.

In Fig. 1, the label corresponding to reference numeral 38 has been corrected to read "emulator" in order to conform to the description of emulator 38 in paragraph [0055] of the Specification.

In Fig. 4, a typographical error concerning reference numeral 86 has been corrected. This conforms to the description at paragraph [0078] which describes virtual machines 86, 88. Originally, Fig. 4 showed two virtual machines, both referenced 88.

The changes in the drawings are explicitly described in the text and do not constitute new matter.

Rejections Under 35 U.S.C. § 112

Claims 1-37 were rejected under 35 U.S.C. § 112. The Examiner has indicated that the independent claims are indefinite in view of the term "node resources". Independent claims 1, 14, and 28 have been amended to more particularly define the invention. The term "nodes" has been replaced by "computers", and the term "node resources" changed to "hardware resources". These amendments are believed to overcome the rejection. Support in the Specification and Drawings is as follows:

In paragraph [0025], it is explained that "nodes" are equivalent to computers:

> . . . an improved cluster-based collection of computers (nodes) is realized using unmodified conventional computer hardware and unmodified operating system software.

Hardware resources are disclosed, for example, at paragraphs [0053] and [0054], together with Fig. 1.

> [0053]   While three nodes are shown, the system 10 is scalable, and any number of nodes may be present, depending on the needs of a particular application and the performance desired. The nodes 22, 24, 26 each comprise computer hardware 28. . .

[0054]   The hardware 28 includes nodal memory 30 and may also be provided with many other types of conventional personal computer devices 32, for example, I/O devices and NIC's or other network communications facilities.

Rejections Under 35 U.S.C. § 101

Claims 28-37 were rejected under 35 U.S.C. § 101 as being directed to non-statutory subject matter. The Examiner has pointed out that the claimed invention includes only virtual machine elements and does not appear to include interaction with an actual physical hardware processor.

Claim 28 as amended recites computers, and is now believed to recite statutory material under 35 U.S.C. § 101. Claims 29-37 depend from claim 28 and are similarly believed to recite statutory material by incorporating the limitations of independent claim 28.

Applicant respectfully disagrees with the Examiner regarding the following claims, all depending from claim 28:

Claim 30 recites physical CPU's, which are virtualized by software elements.

Claim 35 recites controlling a physical PCI controller.

Claim 36 recites controlling a physical DMA controller.

Original claim 37 recited a memory and physical operations thereon (write invalidating; transferring).

Claims 30, 35, 36, and 37 are believed to recite statutory material. They recite operations on hardware elements, thereby effecting useful physical transformations. Applicant therefore

believes that the rejections under 35 U.S.C. § 101 are incorrect (MPEP 7.05.01). In any case, in view of amendments to base claim 28, these claims are believed to recite statutory material for the independent reason that they depend from allowable amended claim 28.

Rejections Under 35 U.S.C. § 103

Claims 1-10, 13-22, 27-33, and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Cellular Disco: Resource Management Using Virtual Clusters on Shared-Memory Multiprocessors*, Govil *et al.*, ACM Transactions on Computer systems, Vol. 18, No. 3 (Govil).

Independent claims 1, 14, and 28 have been amended and are now believed to patentably distinguish Govil.

Govil discloses an arrangement, termed "Cellular Disco", which is an extension of a predecessor system ("Disco"). A virtual machine monitor is combined with a single multiprocessor machine having a shared memory to form a virtual cluster. At page 229, Govil generally describes the system architecture, also shown in Fig. 1 (page 233):

> "Cellular Disco effectively turns a large-scale shared-memory multiprocessor into a virtual cluster that supports fault containment and heterogeneity, while avoiding operating system scalability bottlenecks."

Amended independent claims 1, 14, and 28 now recite a plurality of networked computers, each having respective hardware

resources under control of multiple virtual machine implementers. The amended independent claims thus are directed to an <u>actual</u> <u>cluster</u> of multiple computers, and not a virtual cluster.

Govil clearly differentiates his virtual cluster from the actual cluster that is now claimed. Indeed, Govil discourages the inventive approach. For example, at page 230, Govil states:

> "The solutions that have been proposed to date are either based on hardware partitioning . . . or require developing new operating systems with improved scalability and fault containment characteristics . . . Unfortunately, both of these approaches suffer from serious drawbacks, Hardware partitioning limits the flexibility with which allocation and sharing of resources in a large system can be adapted to dynamically changing load requirements. <u>Since partitioning effectively turns the system into a cluster of smaller machines, applications requiring a large number of resources will not perform well</u>."

Govil continues to extol the virtual cluster over the disfavored hardware cluster. At page 231 Govil teaches:

> "The virtual cluster approach can quickly and efficiently correct resource allocation imbalances in scalable systems. This capability allows Cellular Disco to manage the resources of a scalable multiprocessor significantly better than a

hardware partitioning scheme and almost as well as a highly tuned operating-system-centric approach. <u>Virtual clusters do not suffer from the resource allocation constraints of actual hardware clusters,</u> since large applications can be allowed to use all the resources of the system, instead of being confined to a single partition."

Govil clearly does not disclose the presently claimed invention. Furthermore, being impressed by Govil's admonitions, the artisan seeking to make a virtual computing system would not be attracted toward the cluster of computers claimed in amended independent claims 1, 14, and 28. Applicant urges that these claims are not obvious in view of Govil.

Claims 9-12, 23-26, and 34-36, depending from independent claims 1, 14, and 28, are rejected under 35 U.S.C. § 103 as being unpatentable over Govil in view of U.S. Patent No. 6,862,735 to Slaughter *et al.* (Slaughter). The Examiner cites Slaughter for its disclosure of a wrapper.

Claims 9-12, 23-26, and 34-36, and all other claims depending from independent claims 1, 14, and 28 are believed to be allowable as pending from an allowable base claim.

At the Examiners' suggestion, Applicant has studied the slide available at http://www.cs.jhu.edu/~yairamir/cs437/week7/sld003.htm. The entire content of this slide is "A Distributed Operating System: An operating system which manages a collection of independent computers and makes them appear to users of the system as a single computer." The next slide in the same series

(Slide 4) shows a "distributed architecture" of multiple, autonomous computers. Slide 5 states "Distributed OS - Looks like a virtual uniprocessor (more or less), contains n copies of the operating system, communication via messages, n run-queues." The remaining slides in the series do not appear to be relevant to the present invention.

The very laconic description in the slides (referred to herein as "Yairamir") does no more than to suggest that some sort of distributed operating system may be made to run on a collection of independent computers, using some sort of messaging between the computers, so that the operating system looks "more or less" like a virtual uniprocessor. There is no definition or exemplification of the terms, and if hindsight from the present patent application is put aside, it is possible to imagine many different meanings that may be attached to the description. There is no suggestion in the slides of a virtual machine that runs under a guest operating system and is shared between first and second virtual machine implementers on first and second computers, as recited in the claims of the present patent application.

Furthermore, even if the slides were considered, for the sake of argument, to suggest the arrangement recited in the present claims, the combination of the slides with the other cited references still would not have enabled a person of ordinary skill in the art to practice the claimed invention. The complexity of the claimed virtual machine implementers and their interaction in sharing the virtual machine using the respective I/O devices is evident from the detailed description in the

present patent application. Given the differences between Govil's disclosure and the present invention, as explained above, and with no more than 50 words of description to work with in the slides, the person of ordinary skill could not even have begun to reproduce the present invention.

New Claims

New claims 38-39 are directed to an embodiment which employs no more than one guest operating system to operate a cluster of computers. The amendments are supported, e.g. by Fig. 1, which illustrates an embodiment having a single guest operating system 18. Applicant notes that the slides cited by the Examiner in the interview refer to "n copies of the operating system," as opposed to the single guest operating system recited in the new claims.

In regard to the "n copies" of the operating system, claim 29 recites a first guest operating system and a second guest operating system. In order for the distributed operating system of Yairamir to function, the n copies must be aware of one another. This is a known aspect of distributed operating systems, an example of which is referred to in Yairamir.

Claim 29, (corresponding to Applicant's Fig. 4, and paragraphs [0076]-[0080]) of the Specification), however, recites a first guest operating system and a second guest operating system. Claim 29 recites that the guest operating systems are associated with respective virtual machines – that is they function independently of one another to control different virtual machines, and consequently need have no mutual awareness.

Claim 29 further recites that the two guest operating systems are associated with respective software applications.

Such independence does not occur in the arrangement of Yairamir. Thus, it would not be possible for one of the n operating system copies in Yairamir to control a first software application and another copy to control a second software application. Furthermore, Yairamir provides no disclosure as to how the distributed operating system arrangement referred to in slide 5 could be modified to achieve the invention claimed in claim 29.
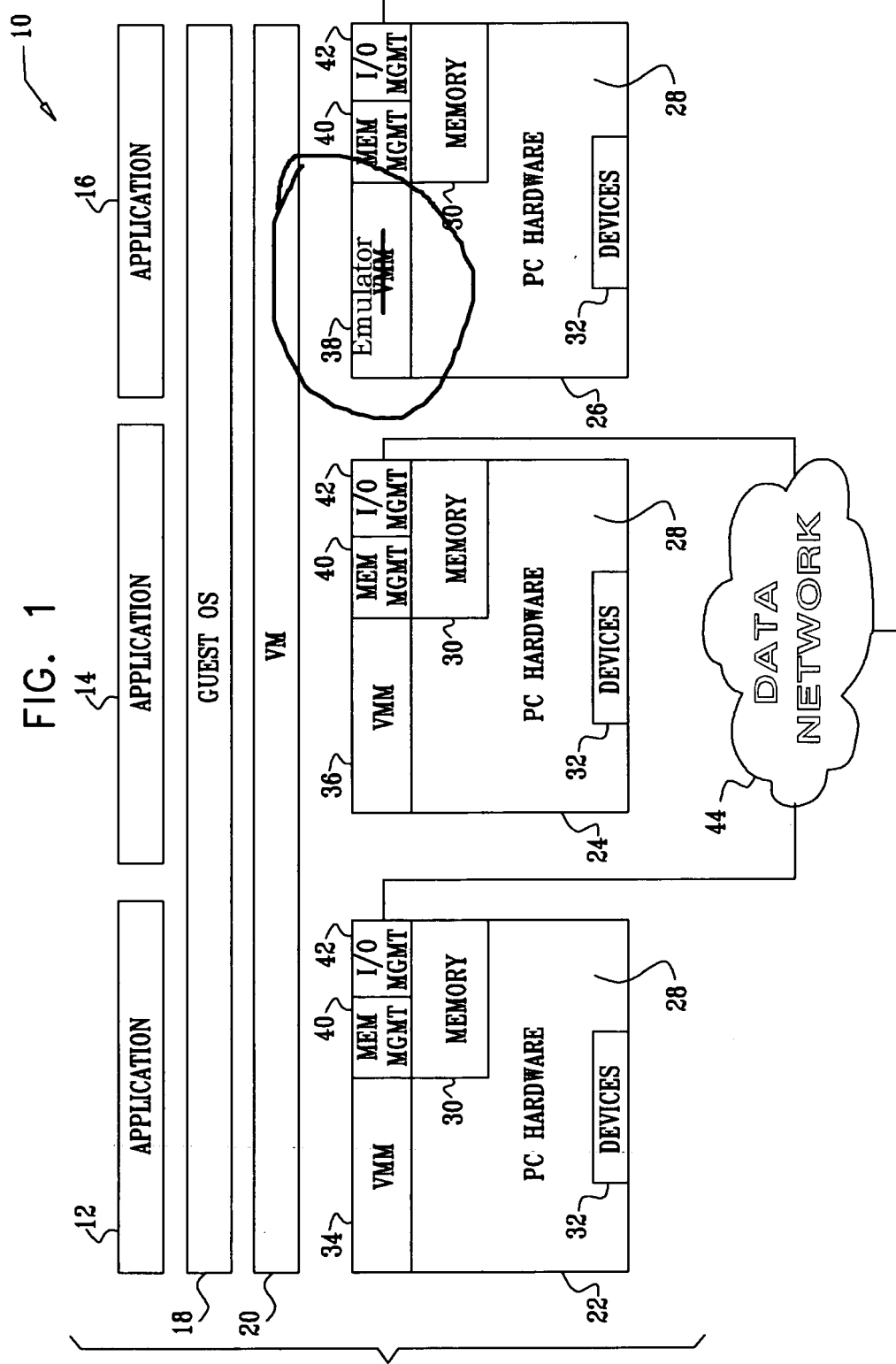
Concluding Matters

It is believed that the amendments and remarks presented hereinabove are fully responsive to all the grounds of rejection and objections raised by the Examiner, and that the Application is now in order for allowance.

Applicant thanks the Examiner for his thorough consideration of the Application and appreciates the careful analysis of the art cited therein.

Respectfully submitted,

Martin P. Hoffman
Reg. 22,261
Hoffman, Wasson & Gitler
2461 South Clark Street
Arlington, Va. 22202

date: 12/6/07
Telephone: 703-415-0100

FIG. 1

10

12 · APPLICATION

14 · APPLICATION · APPLICATION

16 · APPLICATION

18 · GUEST OS

20 · VM

22 · PC HARDWARE
34 · VMM
40 · MEM MGMT
42 · I/O MGMT
30 · MEMORY
32 · DEVICES
28

24 · PC HARDWARE
36 · VMM
40 · MEM MGMT
42 · I/O MGMT
30 · MEMORY
32 · DEVICES
28

26 · PC HARDWARE
38 · Emulator VMM
40 · MEM MGMT
42 · I/O MGMT
30 · MEMORY
32 · DEVICES
28

44 · DATA NETWORK

FIG. 4